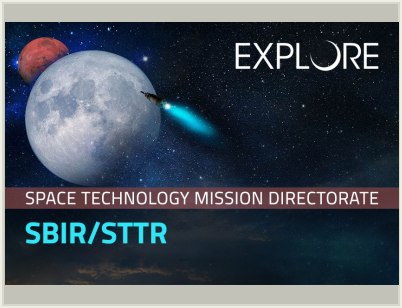
DARWIN-HC: A Tool to Predict Hot Corrosion of Nickel-Based Turbine Disks, Phase II

Completed Technology Project (2011 - 2013)

Project Introduction

Hot Corrosion of turbine engine components has been studied for many years. The underlying mechan-isms of Type I Hot Corrosion and Type II Hot Corrosion are increasingly well-understood. Modern turbine engine designs that seek to achieve better fuel efficiency in part by increasing turbine inlet temperatures are strong candidates for nickel-based superalloy turbine disk materials. As disk temperatures approach 700C, designers must consider the likelihood and effects of Type II corrosion. Type II corrosion is typically characterized by localized corrosion pitting caused by melting of sulfur-containing salts. Type II hot corrosion pits have been shown to decrease the fatigue resistance of superalloys due to initiation of fatigue cracks at hot corrosion pits. However, the rigorous analytical models and tools needed by turbine engine designers to predict Type II corrosion effects are not currently available. The overall objective of this research program will be to develop DARWIN-HC ⬌ a probabilistic Type II hot corrosion, fatigue cracking, and fatigue life prediction software tool for nickel-based superalloy turbine disks. The Phase I research was based on data provided by both NASA and the research team. The key Phase I innovations included enhanced probabilistic models that are explicitly parameterized by the relevant environmental and material variables. The models are a significant step towards modeling the spatial and temporal evolutions of corrosion pits ⬌ setting the stage for the development of fatigue life prediction capability. Whereas the existing DARWIN software contains probabilistic models of hard alpha anomalies in titanium disk materials, DARWIN-HC will feature the probabilistic models of defect distributions due to Type II hot corrosion, which can lead to fatigue crack initiation. In Phase II, the team will create a functional DARWIN-HC prototype software application for evaluation by NASA and industry.



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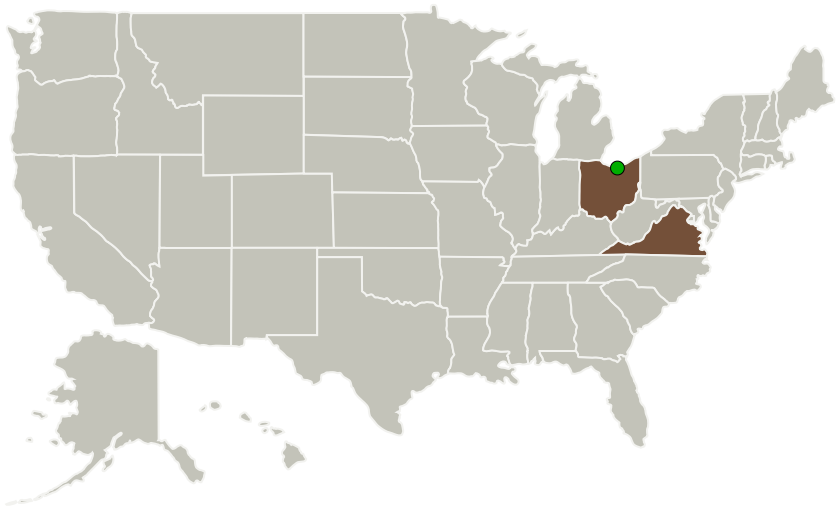
Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
Barron Associates, Inc.	Lead Organization	Industry	Charlottesville, Virginia
Glenn Research Center(GRC)	Supporting Organization	NASA Center	Cleveland, Ohio

Primary U.S. Work Locations	
Ohio	Virginia

Project Transitions

June 2011: Project Start

May 2013: Closed out

Closeout Documentation:

- Final Summary Chart*(https://techport.nasa.gov/file/138787)*

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

Barron Associates, Inc.

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

Project Management

Program Director:

Jason L Kessler

Program Manager:

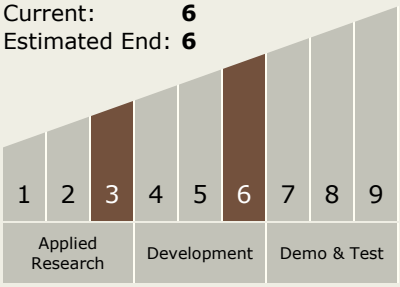
Carlos Torrez

Principal Investigator:

Jason Burkholder

Technology Maturity (TRL)

Start: **3**
Current: **6**
Estimated End: **6**



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Technology Areas

Primary:

- TX12 Materials, Structures, Mechanical Systems, and Manufacturing
  - TX12.2 Structures
    - TX12.2.3 Reliability and Sustainment

Target Destinations

The Sun, Earth, The Moon, Mars, Others Inside the Solar System, Outside the Solar System